REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection or information, including suggestions for reducing this burden. 30 Meahington Headquarters Services, Directorate for information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, OC 20503.

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE		3. REPORT TYPE AND DATES COVERED	
	April 15, 1999	Annual Proges	s Report, 4/15/98-4/15/99	
4. TITLE AND SUBTITLE			5. FUNDING NUMBERS	
Case-Based Reasoning fo	r Decision Making		N00173981G007	
6. AUTHOR(S)				
e. AUTHOR(3)			-	
Dana S. Nau and Hector	Munoz-Avila			
			* **	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)		8. PERFORMING ORGANIZATION	
Department of Computer	Science	•	REPORT NUMBER	
University of Maryland				
A.V. Williams Building	•			
College Park, MD 20742			7 11.1	
9. SPONSORING/MONITORING AGENCY	MANAGES AND ADDRESSIES		40 (00)(00)(00)(00)(00)(00)(00)	
	NAME(S) AND ADDRESS(ES)	·	10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
Department of the Navy Naval Research Laborato	* 37			
4555 Overlook Avenue, S	-		·	
Washington, DC 20375	••			
			es (# weight)	
11. SUPPLEMENTARY NOTES				
			+	
			·	
12a. DISTRIBUTION/AVAILABILITY STAT			126. DISTRIBUTION CODE	
Approved for public rel	ease.			
	•			
13. ABSTRACT (Maximum 200 words)				
This report describes t	he goal of the proj	ect, advances m	ade towards achieving	
that goal in the first				
-				
	· · · · · · · · · · · · · · · · · · ·		المناف المساور المساور	
			10 miles	
· ,	÷ .		*	
·				
	Para Gear	217 A 17 C A	•	
14. SUBJECT TERMS			15. NUMBER OF PAGES	
Dogicion	- 11		5 pages	
Decision support, case	e-based reasoning, p	pranning	16. PRICE CODE	
17. SECURITY CLASSIFICATION 18. S	ECURITY CLASSIFICATION 1	9. SECURITY CLASSIFIC OF ABSTRACT	CATION 20. LIMITATION OF ABSTRACT	
Or REPORT	IT INIS PAGE	UF ABSTRACT		

Annual Progress Report Grant N00173-98-1-G007 from the Naval Research Laboratory (NRL)

Dana S. Nau Héctor Muñoz-Avila

Department of Computer Science University of Maryland College Park, MD 20742-3255 nau@cs.umd.edu (301) 405-2684 | FAX: 405-6707

Abstract

This is the Annual Progress Report of the project under grant N00173-98-1-G007 from the the Naval Research Lab (NRL). It describes the goal of the project, advances made towards achieving that goal in the first year and a plan to be followed for the second year.

1 Goal of the Project

The main goal of the project is to provide a plan authoring tool for decision support during planning of military operations. This project has been developed under intense collaboration between the Computer Science Department of the University of Maryland and the Navy Center for Applied Research in Artificial Intelligence (NCARAI) at the Naval Research Lab (NRL). Point of contact at NCARAI is Dr. David W. Aha.

The application domain for the decision support tool is Noncombatant Evacuation Operations (NEOs). This kind of operations are important because of the frequency with which they occur. Alone in 1997 more than 10 NEOs were performed around the world.

2 Work to Date

We made an study of the application domain and designed an architecture for decision support during planning. These aspects are explained in detail in this section.

2.1 Study of the NEO Domain

A careful study of the domain was made following two information sources:

- Study of bibliography. We studied several unclassified documents which describe NEO doctrine and previous NEO operations performed around the world by the US Armed Forces.
- Interview with NEO experts. We interviewed NEO experts at that Center for Naval Analysis and maintained contact with them during all this period of time.

Based on these studies, we developed an knowledge base consisting of more than 200 tasks and cases.

2.2 Design of an Architecture for Planning

As a result of the study on NEO Operations, we conceived an architecture for decision support during planning called HICAP (<u>H</u>ierarchical <u>I</u>nteractive <u>C</u>ase-Based <u>A</u>rchitecture for <u>P</u>lanning). HICAP is illustrated in Figure 1.

Now we will explain the components in the architecture that has been developed or are under development.

2.3 NaCoDAE/HTN

A conversational case-based reasoning tool, Nacodae, developed at NCARAI served as starting point for this project. It was extended to handle a plan representation technique known as Hierarchical Task Networks. This component is fully developed in Java 2.

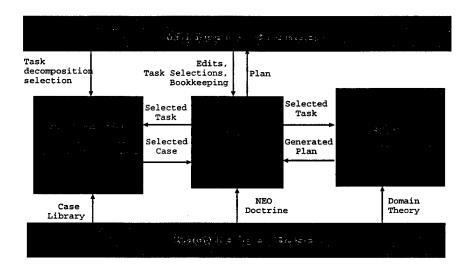


Figure 1: The HICAP architecture.

2.4 HTE

The Hierarchical Task Editor (HTE) has been conceived and developed to handle doctrinal tasks. Doctrinal tasks form a high-level plan. This component is fully developed in Java 2.

2.5 Initial Evaluation of the Architecture

An initial evaluation of the HICAP architecture was made including its NA-CoDAE/HTN and HTE components. This evaluation was performed by manually interacting with a military simulation tool called MoDSAF. The evaluation was a success and its results submitted for publication in a scientific conference.

2.6 SHOP

SHOP (Simple Hierarchical Ordered Planner) is a highly efficient generative planner developed at the University of Maryland. SHOP is being targeted to handle NEO tasks that requires numerical computations. A version of SHOP running on Java 2 is at an advance stage of development.

3 Plan for the Second Year

For the second year, we plan to complete the HICAP architecture, complete the knowledge base for NEO planning, perform a large-scale evaluation with ModSAF and integrate it with IDS.

Now we will explain these objectives with more detail.

3.1 Completion of the HICAP Architecture

Besides completing the implementation of SHOP and integrating it into HI-CAP, we will developed a dependency-maintenance system to ensure global consistency of the plans generated by HICAP. This is particularly important for dealing with user interactions.

3.2 Completion of the Knowledge Base

Although we have made a large knowledge base, several cases have not being integrated yet as first we wanted to make a proof of concept. For the second year we plan to integrate the additional cases to make the case base more robust.

3.3 Large Scale Evaluation

Once the other components of HICAP have been integrate and its knowledge base has been extended, we plan to perform a large-scale experiment using the MoDSAF simulation tool. The scope of the experiments will serve to not only evaluate the architecture but also the encoding of the knowledge base.

3.4 Integration of HICAP in IDS

HICAP is being targeted to serve as the plan formulation component for the Interactive Decision Support (IDS) system being developed at SPAWAR System Center. When completed, IDS will perform distributed plan formulation, execution, monitoring, and replanning for NEO planning efforts.

Bibliography

- Muñoz-Avila, H., Aha, D.W., & Hendler, J. (1998). Conversational Case-Based Planning. To appear in Review of Applied Expert Systems.
- Muñoz-Avila, H., Breslow, L.A., Aha, D.W., & Nau, D.S. (1998). Description and functionality of HTE (TR AIC-98-022). Washington, DC: NRL, NCARAI.
- Muñoz-Avila, H., Aha, D.W., Breslow, L.A., & Nau, D.S. (1999). HICAP: An interactive case-based planning architecture and its application to noncombatant evacuation operations. In Proceedings of AAAI/IAAI-99, July 1999, to appear.
- Muñoz-Avila, H., McFarlane, D., Aha, D.W., Ballas, J., Breslow, L.A., & Nau, D.S. (1999). Using guidelines to constrain interactive case-based HTN planning. (Technical Report AIC-99-004). Washington, DC: Naval Research Laboratory, Navy Center for Applied Research in Artificial Intelligence.
- Nau, D.S., Cao, Y., Lotem, A., & Muñoz-Avila, H.. SHOP: Simple Hierar-chical Ordered Planner. IJCAI-99, August 1999, to appear.